Applicability of Product Lifecycle Management to Small and Medium Scale Enterprises: Issues and Potential Solutions

Ph.D. Synopsis

1. Introduction:

Product Lifecycle Management (PLM) is an enterprise strategy [1] because it involves managing all the data concerning a product, throughout its lifecycle, and all the internal and external factors involved in the development of it. The main goal of PLM is the management of all the business processes and associated data generated by events and actions of various lifecycle agents (both human and software systems) and distributed along the product's lifecycle phases: Beginning of Life (BOL) including design and manufacturing, Middle of Life (MOL) including usage and maintenance and End of Life (EOL) including recycling, disposal or other options [2].

PLM systems are mostly used in each stage of the product lifecycle, to manage the information and data generated from different people and different tools. Companies usually do not exploit the full potentiality of PLM systems and a big amount of information-knowledge is being lost or requires a higher human effort to be preserved. The first problem for small and medium enterprises in the exploitation of a PLM system is the lack of process models to represent in it. In fact, PLM is a software platform for integrating various tools needed by a production process, but it is not a methodology for process modeling. Thus, to be able to exploit the potential of PLM, a company has to first define their processes and then set them in the PLM system [3].

The wide range of functionalities offered by PLM systems are often not fully exploited by companies, especially Small and Medium Enterprises (SMEs) [4], in which the management of data and information about product lifecycle is done without computer software systems. Consequently, a lot of time is spent in managing information “by hand”. One of the key points of the success of enterprises, especially SME that are part of a supply chain [5][6], is the ability to communicate about and around their product. In fact, products generate a large amount of information during their lifecycles. For many years, software as PLM was developed to pool all this information. However, recent surveys evaluate the main difficulties in the implementations of PLM systems in SMEs, such as (i) the gap between the functionalities proposed by the actual software and the needs of some kind of enterprise, especially the raw part makers, (ii) the difficulty of modelling business processes and data models because modelling skills are not sufficiently

present in SMEs, and (iii) the lack of interoperability between PLM and specific software used by enterprises [7].

SMEs usually lack resources who can spend time on planning or think about a new business strategy. The mainly focused on the completion of the first. SMEs hire experts for their skills that bring immediate value, strategic thinking comes second. An engineering department does not hire a strategist they hire a qualified and promising engineer. These new hires are normally not educated on standard PLM concepts like Configuration Management, PLM-ERP (Enterprise Resource Planning) [8] best practices. For an engineering study, these practices/processes are not considered as critical as it is about collaboration and not about skills. The PLM capabilities engineering students learn are the basic functionalities they need master when working with their (Computer-Aided Design - CAD) tools. SME's use their own best practices based on years of experience (before PLM existed) and when they select a PLM system, it is mostly more a data management tool than an infrastructure to streamline processes. Combined with the fact that every PLM vendor has its own definition for PLM, it is hard to have a unified way of thinking for bring in new ways of working supported by a best in class PLM-system.

Leading high-tech companies are driving breakthrough innovation and growing rapidly. But developing today's high-tech products is increasingly complex. It requires systems-level thinking, collaboration across disciplines at the lightning speed. Midsize companies have to overcome this complexity and work closely with their supply chains to meet rapidly changing market demands and compete with their larger competitors in this PLM [9] software can help them. It drives better product development performance by managing product-related data, processes, and projects. While smaller companies may try to control, access, and share product data with relatively simple Product Data Management (PDM) tools [8], larger companies rely on full-featured PLM systems that help automate processes and share data across global supply chains. Midsize companies may find themselves in-between because:

- Product and organizational complexity drive them beyond basic PDM capabilities.
- A full-featured PLM implementation may feel out of reach.

Midsize manufacturers need to choose a system that quickly delivers the core capabilities they need to streamline product development but also gives them room to grow value over time [10].

Some companies try to extend simple file sharing [11] solutions to meet basic PDM [12] capabilities. This might be a simple, low cost option but it leads to a solution that relies on manual processes, conventions, and communication to keep chaos (disordered or confusion) in check. This may be enough for a very small company with a handful of engineers. They can manage the rest outside of the system and engineers can deal over the workspace when they make a change that will impact others. But that approach doesn't hold up to the complexity [13] found in midsize and larger high-tech companies and their increasingly global supply chains.

Ideally, companies could use something as simple as Dropbox or Google Drive to manage product development. Simple apps like these have good user interfaces and file-sharing paradigms that offer companies the fundamentals of data management - controlling, accessing, and sharing

product data online. But they aren't intended to support industrial scale processes like product innovation, development, and engineering and don't support the capabilities and relationships required to manage complex product data. "Unfortunately, many engineers look to solutions designed for consumers and turn to web-based file-sharing services like Dropbox, Google Drive, or others. These offerings have good concepts but have many shortcomings that make them inappropriate for professional use, particularly for CAD file management [11][13]".

2. Review of Literature and Development in the Subject:

Yang Liu [14] presents a workflow engine–driven universal PLM system framework, which is constructed by four layers: client layer, application layer, business logic layer, data layer. The workflow engine–driven universal PLM system framework can be directly used as the PLM system, or can be used to customize the autonomy PLM system for the small and medium-size enterprises. The workflow engine–driven universal PLM system framework is implemented by Java enterprise edition and service-oriented architecture, which has the advantage of lightweight, cross-platform, and so on. They are using the probabilistic Petri net [15][16] as the formal model for the workflow, which can model the function and non-functional behaviors of the workflow in the PLM system which is much more complex in nature and still they are struggling with the cost issue.

Mickaël David and Frantz Rowe [17] made eight proposals distinguishing document-oriented [18-21] PLM applications and relational data-oriented [22][23] PLM applications to help practitioners choose and implement the PLM application best suited to their company's needs. These proposals are illustrated by the comparison of two real cases: one document-oriented and the other relational data-oriented. Overall, this article deals with the complementarity of document management and product relational data management to meet PLM issues in most SMEs.

Fre´de´ric Demoly [24] describes the application of a novel product relationships management approach, in the context of product lifecycle management (PLM), enabling concurrent product design and assembly sequence planning [25][26]. Previous work has provided a foundation through a theoretical framework, enhanced by the paradigm of product relational design and management. This statement therefore highlights the concurrent and proactive aspect of assembly oriented design vision. Central to this approach is the establishment and implementation of a complex and multiple viewpoints of product development addressing various stakeholders design and assembly planning points of view. By establishing such comprehensive relationships and identifying related relationships among several lifecycle phases, it is then possible to undertake the product design and assembly phases concurrently. Specifically, the proposed work and its application enable the management of product relationship information at the interface of product-process data management techniques. Based on the theory, models and techniques such as described in previous work, the implementation of a new hub application called PEGASUS [27] is then described. Also based on web service technology, PEGASUS can be considered as a

mediator application and/or an enabler for PLM that externalizes product relationships and enables the control of information flow with internal regulation procedures.

Fayyaz Rehman and Xiu-Tian Yan [28], have proposes a method which incorporates the knowledge related to the whole context (from the viewpoint of product, user, product's life cycle and environment in which the product operates) of a design problem for the consideration of the designer at the conceptual design stage. The design context knowledge comprising knowledge from these different viewpoints is formalized and a new model and corresponding computational framework is proposed to support conceptual design decision making using this formalized context knowledge. This paper presents a case study to show the proof of the concept by selecting one concept among different design alternatives using design context knowledge thereby proactively supporting conceptual design decision making.

Giulia Bruno and Agostino Villa [29], depicts the problem with PLM is the functionalities of the actual PLM systems are not fully understood by enterprises and to solve this problem author has generated an ontology [30][31] which explores the potential of PLM systems from the point of view of SMEs. The ontology is based on the integration of the static structure of PLM and the dynamic description of the product lifecycle (PLC) processes and focuses on the modeling of a process, to help companies in understanding the process of using a PLM.

Luis Rocha et al. [32] presented the new developments of manufacturing support services. They are based on a set of tools available and accessible through Internet [37], and mainly oriented to SMEs. This set of manufacturing and business tools comprises of three main streams: Computer-aided engineering (CAE) software packages, a Product Life Cycle (PLC) tool, and an Open Innovation (OI) platform. These services are the output of the CloudPyme2 project (CPP2). It has the main goal of providing innovation tools for product development and manufacturing processes to SMEs in a sustainable and affordable way. This project provides these tools as an infrastructure using Cloud Services [33], including High Performance Computing (HPC), hosting platforms, support services and training. This new platform allows SMEs to improve their products and processes, or create new one.

Julien Le Duigou [34] says use of PLM in companies is based on two conditions: first one is the identification of the needs of mechanical SMEs in terms of PLM, and second is the resolution of those needs based on a generic data model. The identification of the needs of mechanical SMEs is done based on companies producing equipment or component or craft parts. The needs of those companies are identified, the processes to respond to those needs are formalized and finally the application of a demonstrator based on a generic model is proposed.

Sylvain Kubler [35], emphasis that PLM tools and systems must be built upon standards for enhancing interoperability among all product stakeholders and developing tools independent of specific vendors, applications, and operating systems. The author developed strategies to improve ‘‘information sustainability’’ in PLM environments using standardized communication interfaces defined by a recent standard proposal named quantum lifecycle management (QLM) messaging

standards. More concretely, data synchronization models based upon QLM standards are developed to enable the synchronization of product-related information among various systems, networks, and organizations involved throughout the product lifecycle. (QLM was recently renamed O-MI standards (standing for Open-Messaging Interface standards).

Ebneter et al. [36] present an approach allowing enterprises to analyze how their business operations can be positively impacted by moving to cloud architecture and the methods to make the transition on the cloud.

3. Objectives of Research/ Proposed Hypothesis:

The available PLM systems are of higher cost provided with multiple options to handle all the aspects of development of product in a company [38]. SMEs can't afford to invest that much amount but they want a kind of solution which will help them to collaborate with larger enterprises and survive in today's competitive market [34]. The next problem with the system is it has multiple or bulk modules available which may or may not be used for SMEs which is ultimately a wastage of resources and money [7].

Available PLM systems are complex in nature as they comprise of multiple operations and for that they need specially trained person to handle the system [39][40].

Listed below are the limitations of current PLM software:

- Too Costly.
- Bulky for SMEs:
  All modules available in the PLM software may not be needed by SMEs
- Huge Customization Required
- Specially Trained Manpower Required.

In order to tackle all the limitations following objectives are derived:

- Undertake study of sample set of SMEs to identify their needs from the viewpoint of making PLM systems applicable and affordable to them.
- Develop a PLM system that is most suited to needs of SMEs.
- Incorporate appropriate level of customization wizards and user friendliness so as to make the PLM system appealing to the SMEs.

4. Methodology to be adopted:

Work Plan:

- It is proposed to establish the need of such software through literature review and industrial survey.
- Define the modules that are required to be incorporated in such a software.
- Identify the required open source software tools that can be used in developing such a software.
- Test the software through pilot implementation at selected industry(ies).

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